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THE DEVELOPMENT OF GLASS-MAKING IN JENA.

Die Glasindustrie in Jena. Ein Werk von Schott und Abbe. Geschildert von Eberhard Zschimmer. Mit Zeichnungen von Erich Kuithan. Pp. 160. (Jena: Eugen Diederichs, 1909.)

THE history of the firm of "Otto Schott und Genossen" may be said to commence from the date of May 27, 1879, when Otto Schott first addressed from Witten, in Westphalia, to Ernst Abbe, professor and director of the observatory in Jena, a letter relating to some experiments he had recently been making in the predection of lithium glass. He wrote:—

> "Recently I produced a glass into which was introduced a considerable amount of lithium, and of which the specific gravity was relatively low. I anticipate that this glass will show, in some direction or other, exceptional optical properties, and would ask you whether you are prepared to examine it as regards its refractive and dispersive qualities to determine whether my anticipation is correct."

The glass had been made in a small experimental furnace of Schott's design. The mixing was imperfect, and Abbe's report was to the effect that the glass contained too many striæ for optical determinations to be made. It was not long before this difficulty was surmounted, and with stirrers made from the stems of Dutch clay pipes, Schott succeeded in producing in small quantities in the laboratory experimental meltings homogeneous enough to allow of a complete determination of their optical properties. This determination, however, brought a new disappointment; for the secondary spectrum of an objective in which the crown glass of Fraunhofer was replaced by the new lithium-crown was more pronounced than before. The lithium glass, indeed, showed exceptional properties, but they were not in the direction desired.

The work was not immediately continued. A year elapsed before Abbe urged that it should be resumed. Schott thought of State aid, but Abbe, more experienced, represented the uselessness of applying for help from public funds until laboratory results of promise had been reached. In a letter of December, 1880, he suggested the main products to be desired from the point of view of technical optics.

(1) Crown glass of appreciably lower mean dispersion than that yet known, or of higher refractive index with the same dispersion.

(2) Flint glass the relative dispersion of which in passing from red to blue agrees more closely throughout the spectrum with that of crown (thus giving smaller secondary colour aberrations).

(3) Flint glass of very high dispersion, but of smaller mean refractive index.

The work was re-commenced on a more comprehensive scale. A systematic examination of glasses of varying composition was planned. To Schott, however, the procedure seemed to promise to be too protracted, and here his general chemical knowledge, and especially his acquaintance with mineralogy, served to shorten the path. Almost instinctively he fixed on the addition of phosphates and borates as the substances most likely to give glasses of novel character. As is well known, his intuition proved correct, and resulted in the foundation of a new industry. On October 7, 1881, Abbe, in sending greetings on the one-hundredth melting, writes:—"The problem of the complete achromatisation of the telescope objective I regard as solved by the two meltings 78 and 93"—two borate glasses.

The next step was the industrial realisation of the results proved possible in the laboratory. For this capital was needed, but in January, 1882, a "Glastechnisches Laboratorium" was founded in Jena by Abbe and Schott, in conjunction with Carl Zeiss and Dr. Roderich Zeiss. It was just at this time that Dr. Wilhelm Förster, director of the observatory and of the Normalaichungskommission in Berlin, was pressing that the Ministry of Finance should give State aid to an industrial research to determine satisfactory glass for the making of thermometers. In February, 1882, the Jena company became acquainted with Förster's aims. It was a matter of course that Schott should be asked to carry out the new investigation. Preceded by an examination of the varieties of thermometer glass then in use, Schott's new experimental meltings began in March, 1883, and by the end of the year promised so well that on this side also the question of the foundation of a new industrial undertaking merited serious consideration. In January, 1884, the promoters entered into new articles of association, with a capital of 60,000 marks, and, with the value of the work urged on them by various physicists of eminence, the Prussian authorities contributed, in the first two years, a further sum of 60,000 marks.

The present work was written to celebrate the twenty-fifth year of the life and development of the Jena glass works. Dr. Zschimmer's volume gives a popular account, not only of the circumstances which led to the foundation of the world-famous works, but of the technico-scientific problems which, in virtue of the researches there undertaken, have one after another been successfully solved. The relation of chemical composition to optical properties, the questions of homogeneity, durability, freedom from mechanical strain and from colour, these and all the main questions connected with the production of glass for scientific purposes are dealt with in a manner which renders them intelligible to the ordinary reader who is not specially interested in the scientific problems involved.

The processes of manufacture, the various types of furnace, the fabrication of the melting-pots, the methods of production of glass vessels of various forms, glass tubes, &c., the machinery for the production of glass bottles, the manufacture of gas-mantle cylinders, and other problems rather of a

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technical than a scientific character, are also dealt with. The special socialistic organisation of the undertaking—in common with that of the Zeiss firm—is shortly described.

The book is printed in a clear antique type and well illustrated with woodcuts of the style of the early days of printing, among which the excellent portrait of Schott himself calls for special mention.

THE MILLAIS GAME-BIRDS.

The Natural History of British Game Birds. By J. G. Millais. Pp. xi+142; illustrated. (London: Longmans, Green and Co., 1909.) Price 8*l.* 8*s.* net.

THE elaborate style in which Mr. Millais produces his more ambitious works renders it necessary that each should be restricted to a comparatively small group, as otherwise the price would be prohibitive to ordinary purses. In the present magnificent volume, which forms a companion to the "Natural History of the British Surface-feeding Ducks," the author has had a splendid opportunity for his artistic talents, as few birds offer finer subjects for illustration than do the members of the grouse and pheasant tribes. Not content with his own powers as an artist, Mr. Millais has secured the cooperation of Mr. Archibald Thorburn, and the combined efforts of these two great bird-painters have resulted in the production of a series of coloured and other pictures which it would be practically impossible to surpass, or even to equal, in effect, beauty of colouring, and general truthfulness to nature.

Too often artistic efforts of this kind are more or less completely marred in the process of reproduction, but in this instance Mr. Millais, as he tells us in his preface, has been fortunate enough to discover a method of reproduction which, in his opinion, far surpasses the best chromo-lithography or three-colour process. This opinion, so far as our experience permits, we are disposed to endorse; and we have certainly seen nothing to equal, let alone surpass, the frontispiece of black grouse, or the plate of red grouse in the red spring phase of plumage. In the coloured plates the birds are for the most part depicted in more or less quiescent poses; but in several of the monochrome plates we have in many instances abundance of action. Among these pictures of active bird-life, special attention may be directed to the two depicting, respectively, the courtship of the grouse and the playing-ground of the ptarmigan.

Possibly, nay probably, the expert would detect errors in some of the plates in regard to the number of primary quills in the wings; but such details would certainly not be noticed by the ordinary observer, and probably not by the majority of sportsmen; and if there be errors in this respect, as we believe there are, they in no wise detract from the general effect of the exquisite pictures. Although the price may appear high, it can scarcely be regarded as excessive for such a magnificent volume, especially when the cost of production and the fact that the issue is limited to 550 copies are borne in mind.

Probably it was the author's intention to convey to his readers all the available information in connection with his subject; but two or three points are noticeable where he has failed in this respect. We cannot, for instance, find any mention of the fact that grouse shed their claws during the main moult; neither does there appear to be any reference to the statements current in Scandinavia as to blackcock burrowing in the snow during winter. More serious is the absence of any mention of the various plumage-changes in the red-legged partridge; and in the case of nearly all the species, much more might have been written about the plumage of the chicks. In connection with partridges, the designations of "common partridge" for the grey species and "common red-legged partridge" for the French bird are by no means satisfactory; grey partridge and red-legged partridge would have been preferable and sufficient.

With the very natural tendency common to all writers of monographs to make the most of their subject, Mr. Millais uses the term British game-birds in a very wide sense, although it must be confessed that in this particular instance it is certainly a difficult matter to know where to draw the line. The red-legged partridge, for instance, is known to have been first introduced into our islands only in the second half of the eighteenth century, and yet it certainly cannot be omitted from any work on British birds. The typical pheasant likewise appears to be an introduced bird, although there is evidence that it had become completely naturalised by the time of the Norman conquest, and there can be no question as to its right to be now included in the British fauna. The introduction of the ring-necked pheasant in the early part of the nineteenth century likewise renders it difficult to exclude that species or race from the British list. When, however, we find such birds as Hagenbeck's pheasant, the Mongolian pheasant, the Prince of Wales's pheasant, the Japanese pheasant, and Reeves's pheasant figuring as British birds, we are on much more debatable ground; and if these are entitled to any mention they should not, in our opinion, have been accorded separate headings.

The author, it may be mentioned, is a strong advocate for regarding closely allied geographical forms in the light of local races rather than distinct species, and consequently classes all the birds mentioned above, with the exception of Reeves's pheasant, as local forms of *Phasianus colchicus*. No doubt there is very much to be urged in favour of this view, although when such a markedly distinct bird as the Japanese *P. versicolor* is classed as a phase of *colchicus* it seems a little difficult to know where to stop.

As we have had to mention on previous occasions, whenever Mr. Millais steps out of his proper province he invariably makes mistakes. Instances of this are afforded on p. 77 of the volume before us, where we find Pikerni for Pikermi and Œmingen for Œningen.

With the above exceptions, we have nothing but unstinted commendation to bestow on Mr. Millais's latest work.

R. L.

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